

**CURRICULUM VITAE**

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**EMPLOYMENT:**

January 2004 – present: Platform Director, Proteomics and Biomarker Discovery, Broad Institute of MIT and Harvard, Cambridge, MA.

September 2003 – September 2004: Visiting Principal Scientist, Barnett Institute, Northeastern University, Boston, MA

April, 2001 – October, 2003: Senior Director, Protein Science and Technology, Millennium Pharmaceuticals, Inc. Cambridge, MA. Led research and application of proteomics in support of target validation, drug mechanism of action, pharmacodynamic marker and disease biomarker discovery and validation. Led protein expression, purification, monoclonal antibody production and protein characterization efforts in support of all discovery programs and disease biology group efforts company-wide.

1997 – April, 2001: Director, of the Department of Computational and Structural Sciences for Upper Merion and Upper Providence Sites at GlaxoSmithKline Pharmaceuticals, King of Prussia, PA; Group Leader, Proteomics and Biological Mass Spectrometry Resource. Led diverse applied research groups (including proteomics, mass spectrometry, computational chemistry, research NMR, *in-vivo* imaging, X-ray crystallography, and biophysical methods) in department of ca. 50 scientists with responsibilities at two R&D sites.

1988 - April, 1997: Associate Director of the Physical and Structural Chemistry Department; Group Leader, Research Mass Spectrometry Resource, SmithKline Beecham Pharmaceuticals, King of Prussia, PA. Collaborative support of Discovery Chemistry and Biology for protein, glycoprotein, carbohydrate and natural product structure analysis by MS-based proteomics, NMR and other spectroscopic methods.

1987: Assistant Director, Physical and Structural Chemistry Department, SmithKline and French Laboratories, King of Prussia, PA.

1984-1986: Senior Investigator, Physical and Structural Chemistry Department, SmithKline and French Laboratories, Philadelphia, PA.

1981-1984: Senior Research Associate, Department of Biological Chemistry; Deputy Director, Mass Spectrometry Facility, Harvard Medical

School, Boston, MA. Chromatographic and mass spectrometric analysis of carbohydrates and glycoconjugates. Investigation of new ionization methods and their application to natural products. Metabolic profiling.

**EDUCATION:** 1980-1984: Postdoctoral Fellow and Visiting Scientist, Department of Chemistry, Massachusetts Institute of Technology, Cambridge, MA. Peptide/protein analysis by MS-based proteomics.

1980: Ph.D., Analytical Chemistry, Massachusetts Institute of Technology, Cambridge, MA

1976-1980: Predoctorate, Massachusetts Institute of Technology, Cambridge, MA. Gas Chromatography Mass Spectrometry (GCMS) of peptides. a) Development of new methodology and chemistry for generating volatile peptide derivatives, b) Isolation and sequencing of proteins containing posttranslationally modified amino acids. Field desorption MS of organometallic radioimaging agents. Maintenance and modification of mass spectrometers. Advisor: Klaus Biemann, Ph.D.

1976-1977: Teaching Assistant, Organic Chemistry, Massachusetts Institute of Technology

1976: B.S., Chemistry, Union College, Schenectady, NY

**AWARDS** 1972-1976: Union College Nott Scholar; 1975: American Institute of Chemistry Award; 1976: Phi Beta Kappa

**PROFESSIONAL  
ACTIVITIES:**

2008: Organizer of Proteomics in Infectious Disease, Institute for Health Metric, University of Washington, Seattle  
2007: Editorial Board, Clinical Chemistry  
2005: Co-organizer of the Asilomar Meeting on Biomarker Discovery and Validation: from Bench to Bedside  
2001 - present: Associate Editor, Molecular and Cellular Proteomics  
2001: Co-organizer of the International Conference on Molecular and Cellular Proteomics, San Francisco, CA  
1999: Co-organizer of the Fourth International Conference on Mass Spectrometry in the Health and Life Sciences, San Francisco, CA  
1997-: Member, Editorial Advisory Board of the journal "Analytical Chemistry".  
1997: Organizer of Asilomar Conference on Mass Spectrometry in Medicine and the Biological Sciences.  
1995: Co-organizer of the first meeting of the Association of Biomolecular Resource Facilities in San Francisco, CA: "ABRF '96: Biomolecular Techniques"  
1994-: Advisory Board Member of NIH-DRR Mass Spectrometry Facility, Rockefeller University

1994: Co-organizer of the Third International Conference on Mass Spectrometry in the Health and Life Sciences, San Francisco, CA  
1994: Member, Editorial Advisory Board of the journal "Mass Spectrometry Reviews".  
1992-: Co-editor of Techniques in Protein Chemistry series.  
1993: Instructor, American Society for Mass Spectrometry Workshops on Electrospray Mass Spectrometry  
1989- 1993: Head, Biomedical Interest Group, American Society for Mass Spectrometry.  
1990- 1996: Member, Editorial Advisory Board of the journal "Journal of Mass Spectrometry" .  
1991-1996: Member, Editorial Advisory Board of the journal "Protein Science".  
1991-1995: Executive Committee, The Association of Biomolecular Core Facilities (ABRF).  
1990-1993: Founding Member, Research Committee on Peptide Synthesis and Mass Spectrometry, ABRF.  
1993- : Founder and Chair, Research Committee on Carbohydrates, ABRF.  
1985- present: Reviewer, Special Study Sections on Biological Mass Spectrometry and Topics relating to Protein Structure Analysis

## PUBLICATIONS:

S. A. Carr, A. Fritzon, L. Hull, T. C. Werner and G. Williams, "Interfacing of a Nuclear Magnetic Resonance Spectrometer to a Low Cost Microcomputer-Based Data Acquisition System," in Microcomputer Design and Applications (S.C. Lee, ed.) Academic Press, 1977.

B. W. Wilson, C. E. Costello, S. A. Carr, K. Biemann, C. Orvig, A. Davison and A. G. Jones, "Field Desorption Mass Spectrometry of Complex Anions Containing Rhenium and Technetium," Anal. Lett. **12**, 303, 1979.

S. A. Carr and K. Biemann, "Gas Chromatographic Mass Spectrometric Sequencing of Peptides and Proteins Containing -Carboxyglutamic Acid," Biomed. Mass Spectrom. **7**, 172, 1980.

S. A. Carr, W. C. Herlihy and K. Biemann, "Advances in Gas Chromatographic Mass Spectrometric Protein Sequencing I - Optimization of the Derivatization Chemistry," Biomed. Mass Spectrom. **8**, 51, 1981.

S. A. Carr, P. V. Hauschka and K. Biemann, "Gas Chromatographic Mass Spectrometric Sequence Determination of Osteocalcin, a 8-Carboxyglutamic Acid-Containing Protein from Chicken Bone," J. Biol. Chem. **256**, 9944, 1981.

S. A. Carr, K. Biemann, S. Shoji, D. C. Parmelee and K. Titani, "N-Tetradecanoyl is the NH<sub>2</sub>-Terminal Blocking Group of the Catalytic Subunit of Cyclic AMP-Dependent Protein Kinase from Bovine Cardiac Muscle," Proc. Natl. Acad. Sci. U.S.A., **79** (20), 6128-31, 1982.

S. A. Carr and V. N. Reinhold, "Sequence Analysis of Polypeptides by Direct Chemical Ionization Mass Spectrometry," Methods Protein Sequence Anal., Proc. Int. Conf., 4th. Meeting Date 1981, Edited by Marshall Elzinga, Humana: Clifton, NJ, 1982, pp. 263-270.

P. V. Hauschka, S. A. Carr and K. Biemann, "Primary Structure of Monkey Osteocalcin," Biochemistry **21**, 4, 638-42, 1982.

P. V. Hauschka and S. A. Carr, "Calcium-dependent  $\mu$ -helical Structure in Osteocalcin," Biochemistry **21**, 10, 2538-47, 1982.

V. N. Reinhold and S. A. Carr, "Direct Chemical Ionization Mass Spectrometry with Polyimide-Coated Wires," Anal. Chem., **54**, 3, 499-503, 1982.

V. N. Reinhold and S. A. Carr, "New Mass-Spectral Approaches to Complex Carbohydrate Structure", Mass Spectrom. Rev. **2**, 2, 1530221, 1983.

V. N. Reinhold, E. Coles and S. A. Carr, "New Techniques for Oligosaccharide Sequencing", J. Carbohydr. Chem. **2**, 2, 1-18, 1983.

S. A. Carr and K. Biemann, "Identification of Posttranslationally Modified Amino Acids in Proteins by Mass Spectrometry," Methods Enzymol. **106** (Posttransl. Modif., Part A), 29-58, 1984.

S. A. Carr and V. N. Reinhold, "Structural Characterization of Sulfated Glycosaminoglycans by Fast Atom Bombardment Mass Spectrometry: Application to Chondroitin Sulfate," J. Carbohydr. Chem., **3** (3), 381-401, 1984.

- S. A. Carr and V. N. Reinhold, "Structural Characterization of Glycosphingolipids by Direct Chemical Ionization Mass Spectrometry," Biomed. Mass Spectrom., **11** (12) 633-42, 1984.
- D. H. Chin, S. A. Carr and I. H. Goldberg, "Incorporation of Molecular Oxygen-18 into Thymidine 5'-aldehyde in Neocarzinostatin Chromophore-damaged DNA," J. Biol. Chem., **259** (16), 9975-8, 1984.
- H. J. Kim, L. K. Mee, S. J. Adelstein, I. A. Taub, S. A. Carr and V. N. Reinhold, "Binding Site Specificity of Gamma-radiation-induced Crosslinking Between Phenylalanine and a Phenylalanine-Containing Tetrapeptide," Radiat. Res., **100**, 1, 30-40, 1984.
- J. Ozols, S. A. Carr and P. Strittmatter, "Identification of the Amino-terminal Binding Group of NADH-cytochrome b<sub>5</sub> Reductase as Myristic Acid and the Complete Amino Acid Sequence of the Membrane-binding Domain," J. Biol. Chem., **259** (21) 13349-54, 1984.
- S. Perlman and S. A. Carr, "Citramalic Acid in Cerebrospinal Fluid of Patients with Bacterial Meningitis," Clin. Chem. (Winston-Salem, NC) **30**, 7, 1209-12, 1984.
- S. A. Carr, V. N. Reinhold, B. N. Green and J. R. Hass, "Enhancement of Structural Information in FAB Ionized Carbohydrate Samples by Neutral Gas Collision," Biomed. Mass Spectrom., **12** (6), 288-95, 1985.
- S. A. Carr, E. Block, C. E. Costello, R. F. Vesonder and H. R. Burmeister, "Structure Determination of a New Cyclodessipeptide Antibiotic from *Fusaria Fungi*," J. Org. Chem., **50** (16), 2854-8, 1985.
- E. Coles, V. N. Reinhold and S. A. Carr, "Fluorescent Labeling of Carbohydrates and Analysis by Liquid Chromatography. Comparison of Derivatives using Mannosidosis Oligosaccharides," Carbohydr. Res., **139**, 1-11, 1985.
- J. W. Crabb, L. G. Ames, S. A. Carr, C. M. Johnson, G. D. Roberts, R. S. Bordoli and W. L. McKeehan, "Complete Primary Structure of Prostapropin, A Prostate Epithelial Cell Growth Factor," Biochemistry, **25**, 4988-4993, 1986.
- S. A. Carr and V. N. Reinhold, "Enhancement of Structural Information in the FAB Mass Spectra of Carbohydrates by MS/MS with Collision Induced Decomposition," Advances in Mass Spectrometry, Part B, pp 1431-1432, 1986.
- S. A. Carr and G. D. Roberts, "Carbohydrate Mapping by Mass Spectrometry: A Novel Method for Identifying Attachment Sites of Asn-Linked Sugars in Glycoproteins," Anal. Biochem., **157**, 396-406, 1986.
- H.-Y. Cheng, L. L. Davis, R. L. Webb, S. A. Carr, G. D. Roberts, D. B. Staiger and G. E. Zuber, "Electrochemical and Spectral Investigations of Oxidative Pathways of 6-Chloro-2,3,4,5-Tetrahydro-1-(4-Hydroxyphenyl)-1H-3-Benzazepine-7,8-Diol (Fenoldopam)," J. Electrochem. Soc., **133**, 515-522, 1986.
- G. D. Roberts, S. A. Carr, S. Rottschaefer and P. W. Jeffs, "Total Structure Determination of Glycopeptide Antibiotics: the Pivotal Role of FAB MS," Advances in Mass Spectrometry, Part B, pp 1501-1502, 1986.

- J. W. Crabb, S. Goldflam, C. M. Johnson, S. A. Carr, L. G. Armes, S. E. Harris, P. E. Mansson and J. C. Saari, "The Complete Amino Acid Sequence of Cellular Retinaldehyde Binding Protein of Bovine Retina," Federation Proceedings, **46**, 2052, 1987.
- S. A. Carr and G. D. Roberts, "Structural Analysis of Glycoproteins: Identification of Carbohydrates and Other Posttranslational Modifications by Mass Spectrometry," in Methods in Protein Sequence Analysis (K. Walsh, ed.) Humana Press, NJ, pp 423-436, 1987.
- S. A. Carr, J. W. Crabb, G. D. Roberts, M. E. Hemling and R. J. Anderegg, "Sequence Analysis of Proteins by Tandem Magnetic Deflection Mass Spectrometry," Federation Proceedings, **46**, 2018, 1987.
- S. A. Carr, K. W. Crabb, G. D. Roberts, M. E. Hemling and R. J. Anderegg, "Sequence Analysis of Proteins by Tandem Magnetic Deflection Mass Spectrometry," Fed. Proc., Fed. Am. Soc. Exp. Biol., **46**, 541, 1987.
- S. Christensen, H. S. Allaudeen, M. R. Burke, S. A. Carr, S. K. Chung, et al., "Parvodisin, A Novel Glycopeptide from A New Species, Actinomadura Parvosata: Discovery, Taxonomy, Activity and Structural Elucidation," J. Antibiotics, **40**, 970-990, 1987.
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- V. N. Reinhold, S. A. Carr, B. N. Green, M. Petitou, J. Choay and P. Sinay, "Structural Characterization of Sulfated Glycosaminoglycans by Fast Atom Bombardment Mass Spectrometry: Application to Heparin Fragments Prepared by Chemical Synthesis," Carbohydrate Res., **161**, 305-313, 1987.
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- L. G. Armes, S. A. Carr, J. W. Crabb, S. Goldflam, S. E. Harris, C. M. Johnson, J. C. Saari, "The Cellular Retinaldehyde-Binding Protein," in Molecular Biology of the Eye: Genes, Visions and Ocular Disease UCLA Symposium on Molecular and Cellular Biology, New Series, Vol. 88, Alan R. Liss, Inc., New York, pp. 107-116, 1988.
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M. E. Hemling, S. A. Carr, C. Capiou and J. Petre, "Structural Characterization of Recombinant Hepatitis B Surface Antigen Protein by Mass Spectrometry," Biochemistry, **27**, 699-705, 1988.

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J. W. Crabb, S. Goldflam, C. M. Johnson, S. A. Carr, L. G. Armes, S. E. Harris, P. E. Mansson and J. C. Saari, "The Complete Amino Acid and cDNA Sequences of the Cellular Retinaldehyde Binding Protein from Bovine Retina," J. Biol. Chem. **263**, 18678-18687, 1988.

S. A. Carr, G. D. Roberts, A. Jurewicz and B. Frederick, "Structural Fingerprinting of Asn-Linked Carbohydrates from Specific Attachment Sites in Glycoproteins by Mass Spectrometry: Application to Tissue Plasminogen Activator," Biochemie (France), **70**, 1445-1454, 1988.

W. D. DeWolf, Jr., S. A. Carr, A. Varrichio, P. J. Goodhart, M. A. Mentzer, G. D. Roberts, C. Southan, R. E. Dolle and L. I. Kruse, "Inactivation of Dopamine  $\beta$ -Hydroxylase by p-Cresol: Isolation and Characterization of Covalently Modified Active Site Peptides," Biochemistry, **27**, 9093-9101, 1988.

A. M. Hassell, K. O. Johanson, P. Goodhart, P. R. Young, B. P. Holskin, S. A. Carr, G. D. Roberts, P. L. Simon, M. J. Chen and M. Lewis, "Preliminary X-Ray Crystallography Studies of Recombinant Human interleukin-1", J. Biol. Chem. **264**, 4948-4952, 1989.

S. A. Carr, G. D. Roberts, W. E. DeWolf, Jr., M. Mentzer, P. J. Goodhart and L. I. Kruse, "The Role of Mass Spectrometry and Tandem Mass Spectrometry in the Structural Characterization of the Active Site of Dopamine  $\beta$ -Hydroxylase Glycoprotein", in Advances in Mass Spectrometry, Vol. 11B, Heyden and Sons, Ltd., 1989, pp. 282-283.

G. D. Roberts, S. A. Carr, C. A. Meyers, K. O. Johanson, L. M. Miles and B. N. Green, "Strategies for Obtaining Complete Sequence Coverage of Proteins by Fast Atom Bombardment Mass Spectrometry: Application to Interleukin-1 $\mu$  and -1 $\beta$ ", in Advances in Mass Spectrometry, Vol. 11A, Heyden and Sons, Ltd., 1989, pp. 1534-1535.

S. A. Carr, M. E. Hemling, G. Folena-Wasserman, R. W. Sweet, K. Anumula, J. R. Barr, M. J. Huddleston, and P. Taylor, "Protein and Carbohydrate Structural Analysis of a Recombinant Soluble CD4 Receptor by Mass Spectrometry", J. Biol. Chem., **264**, 21286-21295, 1989.

S. A. Carr, G. D. Roberts and M. E. Hemling, "Structural Analysis of Posttranslationally Modified Proteins by Mass Spectrometry," in Mass Spectrometry of Biological Materials, Marcel Dekker Inc., C. N. McEwen and B. Larsen, eds., 1990, pp. 87-136.

S. A. Carr, "Recent Advances in the Analysis of Proteins by Mass Spectrometry, Drug Delivery Reviews, 4, 113-147, 1990.

M. Oka, H. Johansen, B. Okita, B. Wilson, S. A. Carr, G. Roberts, T. Chen., J. Strickler, and S. Mai, in *Advances in Animal Cell Biology and Technology for Bioprocesses*, pp. 465-471, 1990.

M. E. Hemling, G. D. Roberts, W. Johnson, M. F. Bean, and S. A. Carr, "On-Line Coupling of Microbore HPLC with Flow FAB and Electrospray MS for Facile Characterization of Proteins and Glycoproteins at the Picomole Level", *J. Prot. Chem.* 9, 321-323 (1990).

S. A. Carr, M.F. Bean, G. D. Roberts and M. E. Hemling, "Integration of Mass Spectrometry in Biopharmaceutical Research", in *Biological Mass Spectrometry*, A. L. Burlingame and J. McCloskey, Eds., Elsevier Science Publishers B.V., Amsterdam, The Netherlands, 621-652, (1990).

S. A. Carr, J. R. Barr, G. D. Roberts, K. Anumula, and P. Taylor, "Identification of Attachment Sites and Structural Classes of Asparagine-Linked Carbohydrates in Glycoproteins", *Methods in Enzymol.*, 193, 501-518, (1990).

C-T. Yuen, S. A. Carr, and T. Feizi, "The Spectrum of N-Linked Oligosaccharide Structures Detected by Enzymic Microsequencing on a Recombinant Soluble CD4 Glycoprotein from Chinese Hamster Ovary Cells", *Eur. J. Biochem.*, 192, 523-528, (1990).

W. R. Harris, D. A. Malencik, C. A. Johnson, S. A. Carr, G. D. Roberts, E. H. Fischer, L. M. G. Heilmeyer, Jr., S. R. Anderson, and J. W. Crabb, "Purification and Characterization of a Catalytic Fragment of Phosphorylase Kinase Gamma Subunit Missing a Calmodulin Binding Domain", *J. Biol. Chem.* 265, 11740-11745 (1990).

S. E. Harris, M. A. Harris, C. M. Johnson, M. F. Bean, J. Dodd, R. J. Matusik, S. A. Carr, and J. W. Crabb, "Structural Characterization of the Rat Seminal Vesicle Secretion II Protein and Gene", *J. Biol. Chem.* 265, 9896-9903 (1990).

M. F. Bean, S. A. Carr, E. Escher, W. Neugebauer, and J. Samamen, "Identification of a Thioether By-Product in the Synthesis of a Cyclic Disulfide Peptide by Tandem Mass Spectrometry", *Peptides, the Proceedings of the 11th American Peptide Symposium*, (1990).

M. S. Oka, K. -L. L. Fong, S. A. Carr, and R. Shebuski. "Characterization and Biological Properties of Recombinant tPA Produced in Drosophila Cell Culture", in "Trends in Animal Cell Culture Technology", *Proceedings of the Japanese Association for Animal Cell Technology*, pp. 161-166, (1990).

M. E. Hemling, G. D. Roberts, W. Johnson, T. R. Covey, and S. A. Carr, "Analysis of Proteins and Glycoproteins at the Picomole Level by On-Line Coupling of Microbore HPLC with Flow FAB and Electrospray MS: A Comparative Evaluation", *Biomed. Environ. Mass Spectrom.*, 19, 677 - 691, (1990).

C. Capiou, S. A. Carr, M. E. Hemling, D. Plainchamp, K. Conrath, P. Hauser, E. Simoen, M. Comberach, P. Roelants, P. Desmons, P. Permanné, J. Petre, **Proc. 6th Intl. Symp. Pertussis**; C. R. Manclark, Ed.; Dept. Health & Human Services, US Public Health Service, Bethesda, MD



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M. F. Bean and S. A. Carr, "Characterization of Disulfide Position in Proteins and Sequence Analysis of Cystine-Bridged Peptides by Tandem Mass Spectrometry" *Anal. Biochem.* **201**, 216-226, (1992).

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M. J. Huddleston, M. F. Bean, and S. A. Carr, "Collisional Fragmentation of Glycopeptides by Electrospray Ionization LC/MS and LC/MS/MS: Methods for Selective Detection of Glycopeptides in Protein Digests," *Anal. Chem.* **65**, 877 - 884 (1993).

S. A. Carr, M. J. Huddleston, and M. F. Bean, "Selective Identification and Differentiation of N- and O-linked Oligosaccharides in Glycoproteins by Liquid Chromatography-Mass Spectrometry", *Protein Science*, 2, 183 - 196, (1993).

M. J. Huddleston, M. F. Bean, and S. A. Carr, (1993) Selective Detection of Phosphopeptides in Mixtures by Electrospray LC-MS. *J. Amer. Soc. Mass Spectrom.* 4, 710 - 717.

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